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Managing Water in the West

ABMet® Treatment Technology

Pilot Tests in the San Joaquin Valley

Scott Irvine, P.E.
Water Treatment Engineering & Research Group
Technical Services Center, Denver, Colorado



U.S. Department of the Interior
Bureau of Reclamation

Overview

- **Purpose**
- **San Luis Drainage Feature Re-evaluation (SLDFR)**
 - History
 - Evaluation of Alternatives
 - In-Valley Treatment and Disposal
- **Biotreatment for Selenium Removal**
- **Questions and Contacts for Information**

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Presentation Purpose

- **Provide information to Salton Sea Advisory Committee on our experience with the ABMet® technology in the San Joaquin Valley**
 - Results of biotreatment testing
 - Operational concerns
 - Environmental issues
 - Future plans
 - Answer questions

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Project History

- | | |
|-------------|-------------------------------------|
| • 1960 | San Luis Act |
| • 1968-1975 | San Luis Drain Partial Construction |
| • 1983-1985 | Selenium Toxicity at Kesterson |
| • 1992-1995 | Sumner-Peck Litigation & Judgment |
| • 2000 | U.S. Court of Appeals Judgment |
| • 2001 | Reclamation files Plan of Action |
| • 2002 | Plan Formulation Report Completed |
| • 2004 | Amended Plan for Land Retirement |
| • 2005 | Publish Public Draft EIS |

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Project Location

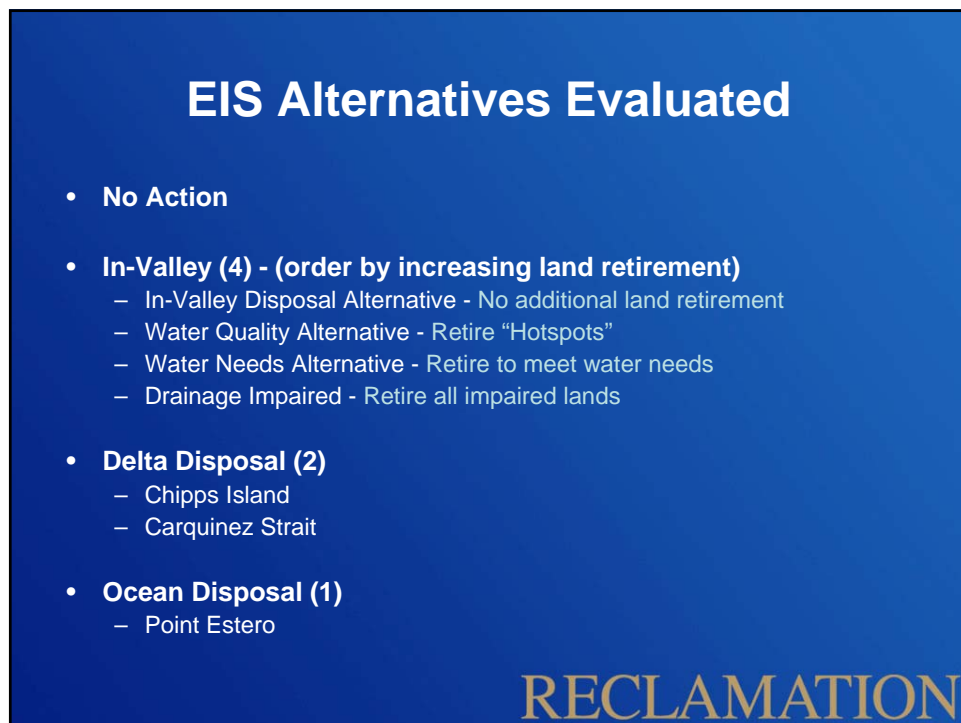
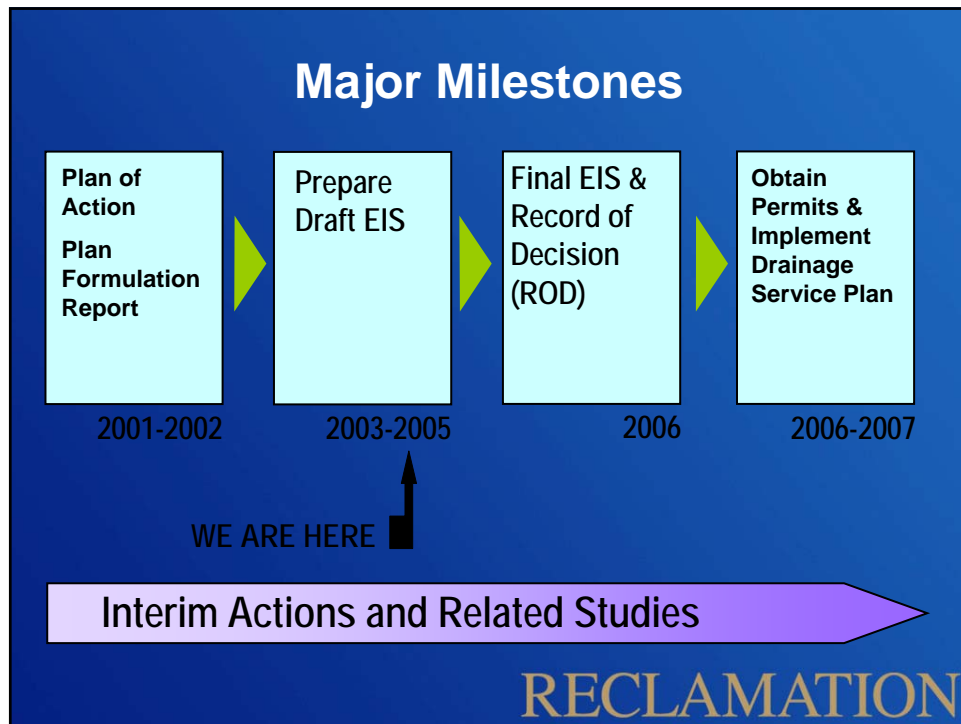


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SLDFR Project Objective

- Department of the Interior. . .shall without delay, provide drainage to the San Luis Unit, pursuant to the statutory duty imposed by section 1(a) of the San Luis Act.”
- Amended Plan of Action February 2004 allows for consideration of land retirement as a component of drainage service.
- Drainage plan developed must meet environmental requirements, be best plan for the federal interest, and fulfill conditions of the lawsuit.

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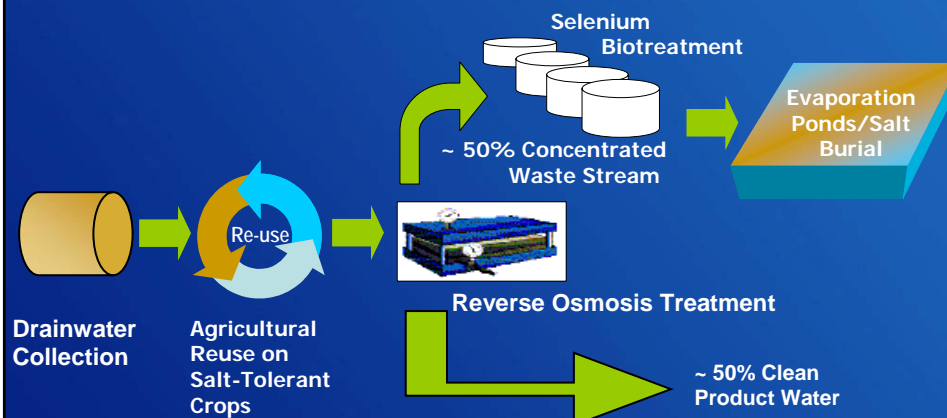


Project Location



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In-Valley Treatment and Disposal



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Selenium Treatment Options

- **Chemical – precipitation and immobilization**
 - Somewhat effective
 - Creates large volume of sludge
 - Expensive compared to other technologies
- **Physical – separation (e.g., RO membranes)**
 - Separates and concentrates Se in a waste stream
 - Waste stream requires further treatment/disposal
- **Biological – reduction to elemental Se**
 - Very effective
 - Preliminary analysis indicates least expensive
 - Residual Se in effluent may be more toxic than influent Se

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ABMet® Biotreatment Technology

- **Microbes reduce soluble Se to insoluble Se**
- **Microbes attached to carbon media within tanks**
- **Water flows thru tanks; insoluble Se retained within biomass in tanks**
- **Uniqueness of ABMet® technology**
 - Specialized, laboratory-bred microbes
 - GAC media for interface between microbes and water
 - Nutrient for microbes

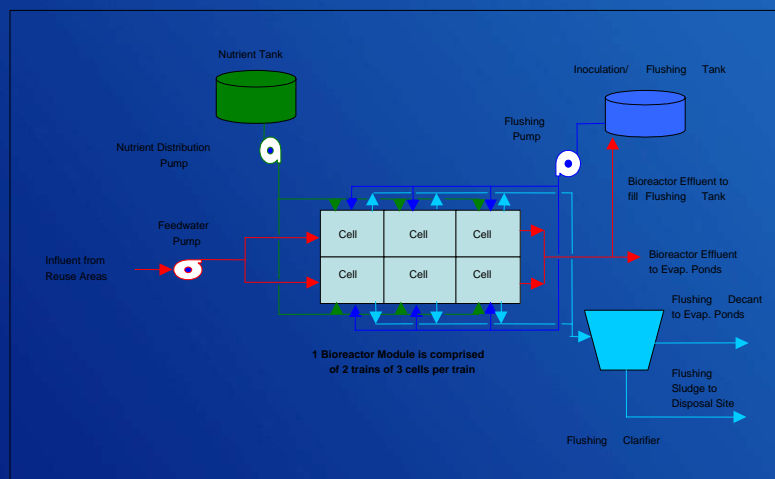
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ABMet® Evaluation for SLDFR

- Laboratory bench test 2002
- Phase 1 pilot test 2003
- Phase 2 pilot test 2004
- Site visit to Canada plant 2004
- Se bioaccumulation study 2004 - 2005
- Phase 3 pilot test 2005
- Demonstration facility? 2006 - 2007

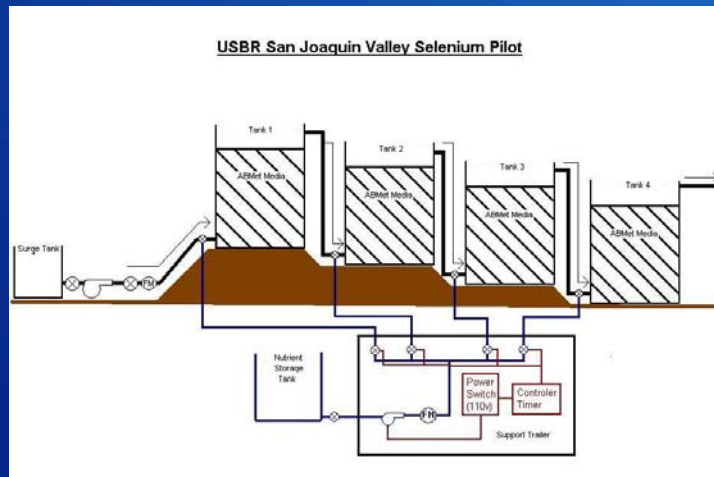
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Biotreatment Process Schematic



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ABMet® Phase 1 Pilot Schematic



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Phase 1 Bioreactors – Panoche Site



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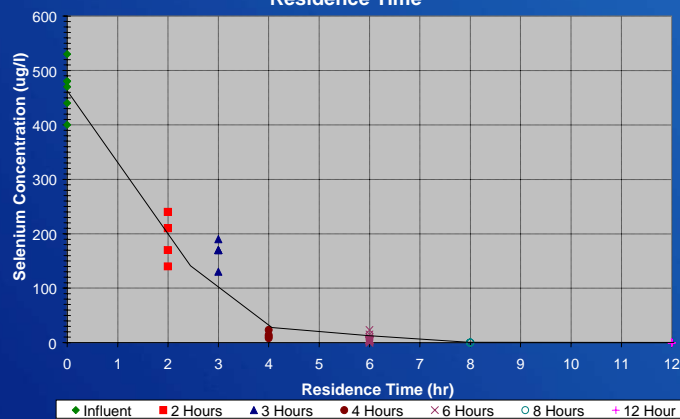
Nutrient Tank at Panoche



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Phase 1 Pilot Se Removal

Bioreactor Effluent Selenium Concentration vs.
Residence Time



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Phase 1 Conclusions

- **Effective Se removal**
 - 99% removal: 500 µg/L in influent to 5 µg/L in effluent
 - Bioreactor residence time: 4 to 8 hours during summer
 - Four tanks in series not needed
- **Flow system became plugged**
 - Combination of biomass and GAC impeded water flow
 - Gravity head not adequate to overcome plugging
 - Problem should be solvable with proper design
- **Include ABMet process for drainage service plan**
 - Additional pilot testing required

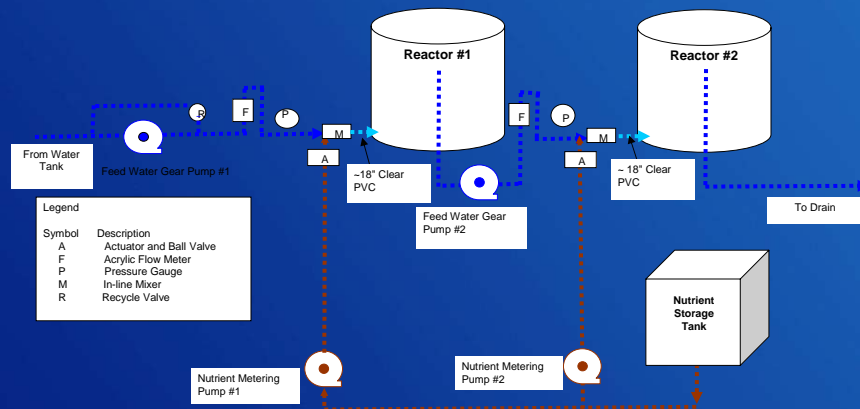
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Phase 2 Pilot Tests - 2004

- **Hired engineering firm to design plumbing**
 - Use pumps instead of gravity flow
 - Add more gravel at bottom of tanks
- **Moved two tanks to Red Rock Ranch in Westlands**
 - Feedwater is from sump in reuse area
 - RRR drainage salinity/Se concentrations > Panoche site
 - Higher salinity/Se waste streams available from evaporation experiments
- **Two tanks remain at Panoche site**
 - Add RO pilot system
 - Feedwater to bioreactors is RO concentrate

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Phase 2 Biotreatment Schematic



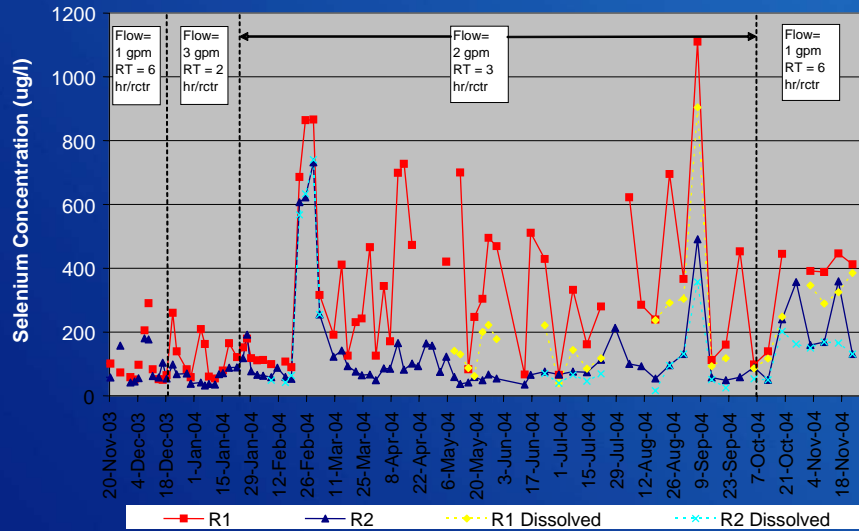
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RRR Bioreactors – Phase 2



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RRR Results – Phase 2



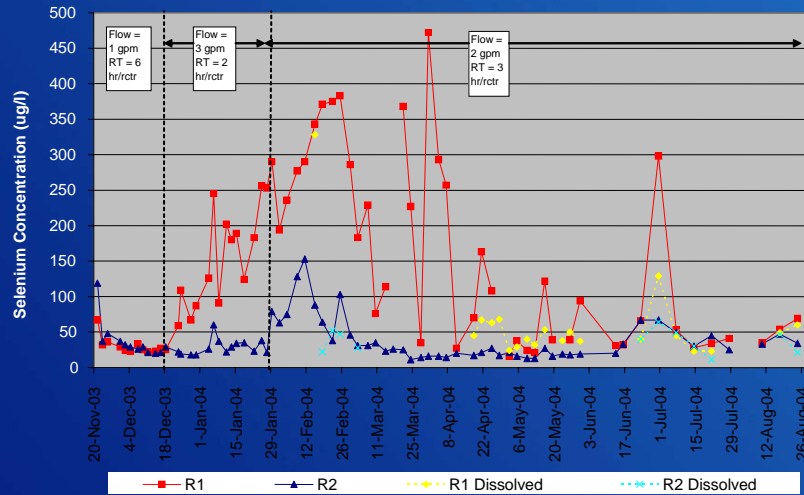
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RRR Results (continued)

Total Retention	Influent	R1 Effluent	R2 Effluent			
Time (hrs)	Ave. Tot. Se (ug/L)	Ave. Tot. Se (ug/L)	Ave. Tot. Se (ug/L)	R1 % Removal	R2 % Removal	Overall % Removal
12	1020	106	94	89.6	11.7	90.8
12	883	331	194	62.5	41.4	78.0
6	980	315	119	67.8	62.3	87.9
4	1235	137	73	88.9	47.0	94.1

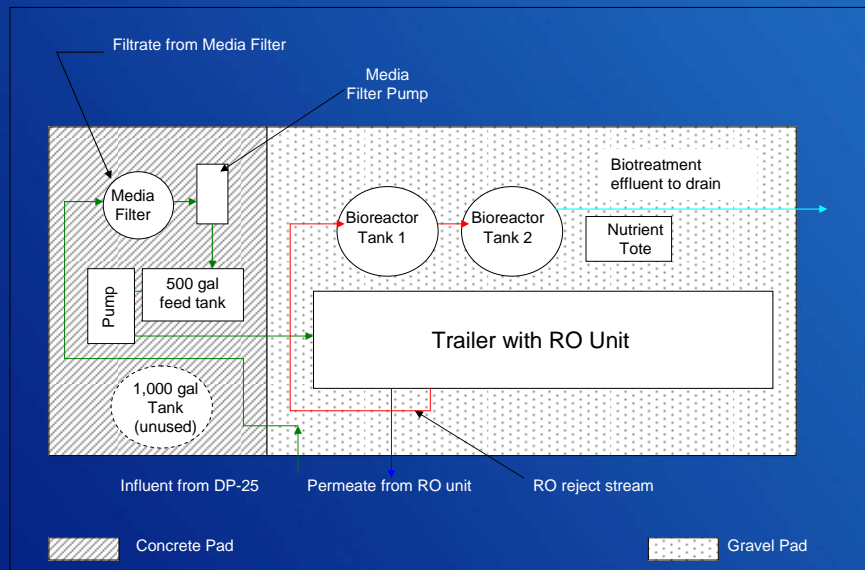
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Panoche Results – Phase 2



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Plan View of Panoche RO and Se Pilot Systems



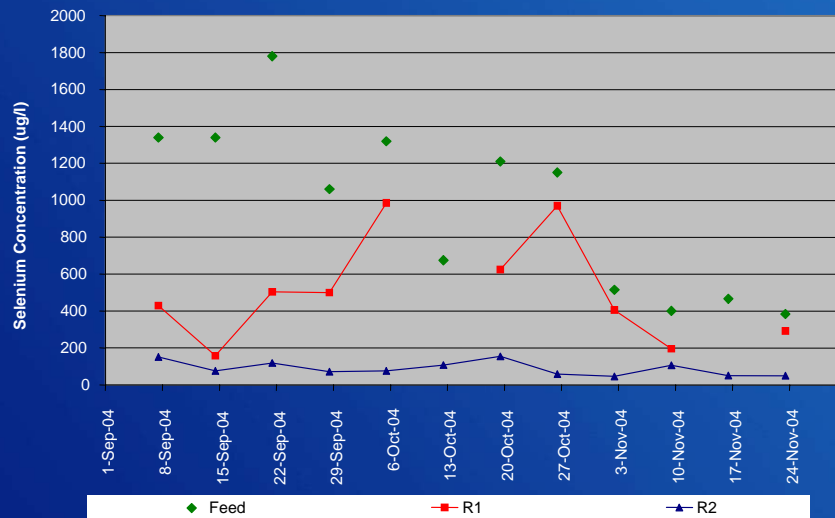
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Panoche RO and Se Pilot Equipment



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Se Removal from RO Concentrate



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Gas Production – GAC Expansion



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More Gas Expansion



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Where's the Pepto-Bismol?



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GoldCorp Biotreatment Plant



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Phase 2 Conclusions

- **Effective Se removal, but less than Phase 1**
 - Consistent 90% removal at both pilot sites
 - Varying influent salinities, 9 – 23 mS/cm
 - Varying influent Se concentrations, 300 – 1400 µg/L
 - Varying water temperature, 15 – 25 °C
 - Plumbing modification fixed Phase 1 plugging
 - Longer Phase 2 pilot revealed other design deficiencies
 - Bioreactor tanks need capacity for gas expansion
 - Inadequate nutrient and water flow controls
 - Inadvertent air injection to anaerobic bioreactors
- **Additional pilot testing required**

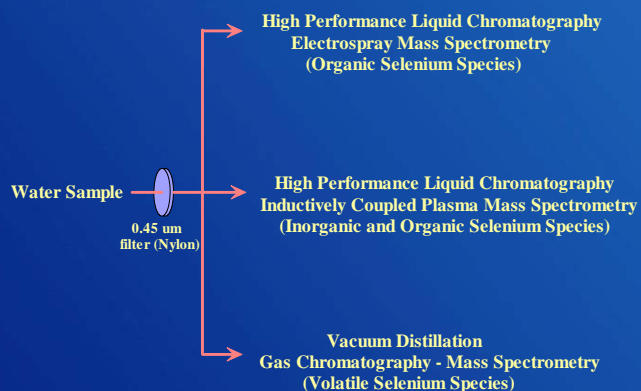
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Planned Phase 3 Pilot Tests – 2005

- **New, taller bioreactor tanks**
 - 6 ft diameter x 12 ft high
 - False-bottom plenum with nozzles to reduce plugging
 - Stainless-steel construction, concrete pad for support
- **Replenish with new GAC to 5-ft depth**
- **Water depth above GAC about 5 ft**
- **Improved instrumentation and data acquisition**
- **Selenium speciation analyses**
- **Post-treatment oxidation to reduce toxicity**
- **Selenium bioaccumulation pilot study**

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Se Speciation Approach



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Selenium Speciation Analyses



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Preliminary Se Speciation Results

- Dimethylselenide was detected in post-bioreactor water samples, but not in pre-bioreactor water samples.
- Selenocystine was identified, but could not be quantified accurately due to high levels of matrix interferences in the water samples.
 - A new chromatographic separation with more selectivity is being developed.
 - Extraction and desalting cleaning procedures were developed to reduce matrix interferences. Recoveries of spiked SeMet, SeCys, and SeEt were 90-98%.

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Post-Treatment Oxidation of Residual Se

- **Residual organic Se species in treated effluent more bioavailable and toxic than inorganic Se species**
- **Potential solution: Post-treatment oxidation**
 - Oxidize residual organic species to less toxic inorganic species
- **Laboratory jar and field pilot-evaluation in 2005**
- **Results will be used to assess environmental impacts and mitigation requirements**

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Selenium Bioaccumulation Study

- **Conducted by URS Corporation at Panoche site**
- **Bioreactor effluent discharged to evaporation pond**
- **Monitor colonization and productivity of algae and invertebrates in evaporation pond cells**
- **Monitor and analyze selenium**
 - Water analyses in evaporation pond cells
 - Tissue analyses of organism in evaporation ponds
 - Water and media analyses from bioreactors

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Future Activities

- **UC Salinity/Drainage Annual Conference**
 - March 22, 2005: Doubletree Hotel, Sacramento
 - www.waterresources.ucr.edu
- **Selenium Treatment Technology Symposium**
 - March 23, 2005: Doubletree Hotel, Sacramento
 - Focus on biotreatment technologies
- **Develop Se Advisory Committee**
 - Treatment, environmental impacts, and mitigation
- **Phase 3 Pilot Studies: April – October 2005**
- **Develop Treatment Demonstration Facility**
- **EIS and Record of Decision**

May through July 2005: EIS Public Review

July 2006: Complete Final EIS and ROD

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Questions and Contacts

- Jerry Robbins, SLDFR Project Manager, Bureau of Reclamation, Sacramento, CA; 916-978-5061
- Michael Delamore, Drainage Program Manager, Bureau of Reclamation, Fresno, CA; 559-487-5039
- Scott Irvine, Technical Team Leader, Bureau of Reclamation, Denver, CO; 303-445-2253

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